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FRESH WATER RED ALGAE IN WATER EFFLUENTS OF THERMAL POWER HOUSE AT JAMSHORO, SINDH, PAKISTAN

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Abstract

Five species of fresh water red algae viz., *Audouinella hermannii* Roth, *Batrachospermum* cf. *arcuartum* Kylin; *Compsopogon coeruleus* (Balbis) Montagne; *Composopogon* cf. *prolificus* Yadava et Kumano and *Thorea hispida* Desvaux were found growing in the water effluents of a thermal power house located at Jamshoro, Sindh, Pakistan. Of these *A. hermannii* and *C. coeruleus* were found preponderant during January and April.

Introduction

A vast majority of red algae are marine and only a few fresh water forms are found in well aerated water falls and streams (Prescott, 1962; Kumano, 1980; Sheath, 1984, Sheath & Hambrook, 1988; Sheath & Hymes, 1980) or stagnant ponds (Sheath, 1984). In Pakistan, Faridi (1975) has made a detailed study on the genus *Batrachospermum* and has reported the occurence of *Compsopogon coeruleus* (Balbis) Mont; *Lemanea mamillosa* kg; *Audouinella violacea* Hamel and *Asterocystis smaragdina* (Reinsch) Forti from North Western province. Nizamuddin (1988) reported *Bangia atropurpurea* Roth from soft fresh water arising from hot water falls in Chitral district. Recently Hagua *et al.*, (1995) recorded fresh water red alga *Bangia atropurpurea* (Roth) Ag. from Kawai N.W.F. Province of Pakistan. The present report describes the fresh water red algae found in the effluents of a thermal power electric generation station located at Jamshoro, Sindh Pakistan. It takes about 70-80 tons of water per/hour from the River Indus for cooling the turbines and about 75% water is discharged as effluent which flows in open channels.

Materials and Methods

Water samples in one liter glass bottles and plant samples were collected at monthly interval from 3-6 inches depth from village Chakar Khan at Petaro Road about 1-2 km away from thermal power station. Water temperature and transparency with sacchi disk at the time of collection were recorded. pH was measured using Orian 420 A pH meter and conductivity with Janway 4017 conductivity bridge. Chloride, hardness and alkalinity were determined by titration with standard silver nitrate (0.014n), EDTS (0.01M) and hydrochloric acid (0.01N). The total residue was determined by the

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Table 1. Physical and Chemical characteristics of effluent of thermal power house at Jamshoro

Date	10-3-1995	5-4-1995	23-6-1995	5-12-95
Time	11:30	10:20	3:20	3:25
Temperature °C	36.00	32.5	37.0	34.00
Temperature H_2O°C	21	22	26	24
pH	7.1	7.59	8.34	8.77
Conductivity US/CM	840	840	535	636
Total residue mg/L	760	710	640	670
Voltile mg/L	155	186	144	151.8
Fixed mg/L	605	530	496	518.2
Hardness as $CaCO_3$ mg/L	135	145	140	130
Chloride mg/L	386	263	380	360
Phosphate mg/L	28.84	30.31	32.22	27.41
Nitrate mg/L	1.9	1.8	1.9	2.03
Nitrite mg/L	33.7	38.9	42.5	40.6
Dissolved/oxygen mg/L	4.49	5.18	5.45	4.92
C.O.D. mg/L	196	182	175	180

evaporation of known volume (50ml) of water and drying the residue at 105° C. Fixed and volatile residues were estimated after heating the total residue at 550° for about two hours. The loss in weight corresponded to volatile residue and remaining to fixed residue. Phosphate was determined spectrophotometrically by the reduction of phosphomolybdic acid to moledenum blue by ascorbic acid. Dissolved oxygen was evaluated by conventual Winkler method (Table 1).

The red algae were collected with a forcep from the grases and submerged plants viz., *Potamogeton pectinatus*, *Typha domogensis, Phragmites cummunis*, *Cladophora glomerata* or from submerged stones at depth of 12-14". The samples were examined under stereo microscope (Swift Japan) and the drawing were made by the camera lucida. Original photographs were also taken and identified after reference to the work of Prescott (1962), Necchi *et al.*, (1993), Sheath *et al.*, (1993), Viz *et al.*, (1992, 1995). The data is presented in Table 2.

Systematic Accounts:

Audouinella hermannii **(Roth) Duby. 1830. Nechi, 1993. 70:11-28.**
(Fig.1)

Thallus erect and straight bright violet in colour, 1.5-3 mm long, branched, branches opposite, alternate in a series, branch angle 30-35°, flattened at the top, cells 7-9.1 (12) um broad and 30-48 um long, chloroplast parietal laminate with many plate

Table 2. Seasonal distribution of red algae in thermal effluents of Jamshoro, 1995.

Month	*Audounelia hermannii*	*B.cf. arcurtum arcuartum*	*Cosposopogon coeruleus*	*Comoposogoopn prolificus*	*Thorea hispida*
January	+ + +	+ +	+ + +	+ +	+
February	+ + +	+ +	+ + +	+ +	-
March	+ + +	+ +	+ + +	+ +	-
April	+ +	+ +	+ + +	+ +	-
May	+ +	+	+ +	+ +	-
June	+ +	+	+ +	+ +	-
July	+	-	+	+	-
August	+		+	+	-
September	+	+	+	+	-
October	+ +	+	+	+	-
November	+ +	+	+ +	+ +	-
December	+ +	+	+ +	+ +	-

- Absector, + herely presence, + + Commonly presence, + + + Dominent changes

like chromatophores, reddish to violet in colour. Reproduction by monosporangia at the tip of each branch, 9-15 um broad and 18-30 um long bearing 1-2 carpospores.
Occurence: *Audouniella hermannii* occurs througout the year in the shadow and cool places, epiphytic on the submerged sheathy stem of *Typha domogensis* and *Phragmites karka*.
Remarks: Our results are similar to those of Islam (1982) and Necchi *et al.*, (1993). Monospore observed in our specimen were long.

Batrachospermum cf. arcuatum **Kylin; Vis, 1995. 30:35-55.**
(Fig.2)

Thallus dioecious, beaded, macroscopically 10-14 cm. long, violet brown in colour developed whorls confluent barrel shaped about 500-800 um in diameter with peripheral carposporophytes. The main axis is with cortication consisting of cylindrical cells only, carposporophyte spherical pedicellate 90-130 um in diameter, gonium blast filaments with few cylindrical cells. Carpogonia 27.5-40 um long with clavate trichogynes, whereas carposporangia obovoid, 12-15 um long and 9-10.5 um broad.
Occurence: *Batrachospermum cf. arcuatum* was found benthic, attached with the stones at the depth of about 12-48" and found epiphytic on the *Cladophora glomerata*. *Batrachospermum* cf. *arcuatum* with maximum growth at water temperature ranging from 20-25^{O}C recorded during November to March, whereas at temperature abovt 28^{O}C disintegration with the loss of pigments was found.

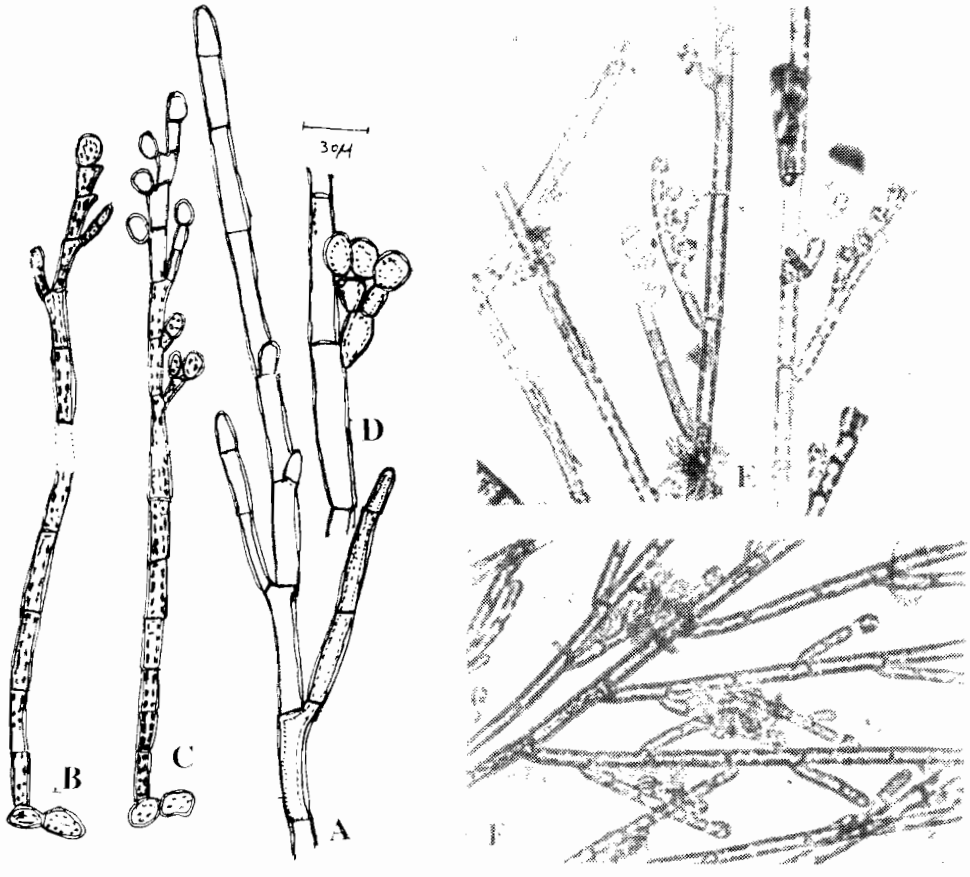

Fig. 3. *Audouinella hermannii* (Roth) Duby

A-B-C. Habit of the thallus. (x66).

D-F. Filaments with monosporangium (x400).

Composopogon coeruleus **(Balbis) Montagne 1846. la Rivers, 1978, p. 263, Fig.337; Vis *et al*., 1992. 31 (6): 564-/5.**

(Figs.3)

Thallus olive green growing with lose tufts of 0.5-9mm in length where rhizoid is confined to the thallus base without curling branches. Main axis 150-3000 (5000) um broad; cortical branches 12-98 um broad with cortical layer 1-5 or more.

C. coeruleus occurs throughout the year as epiphytic associated with *Cladophora glomerata* and on the submerged parts of *Typha domogensis, Phragmites karka, Potamogeten pectinatus* together with *lyngbya* sp and *Audouninella hermannii*. This species was found to grow upto 28^{O}C, with some loss of pigments and later becoming colourless.

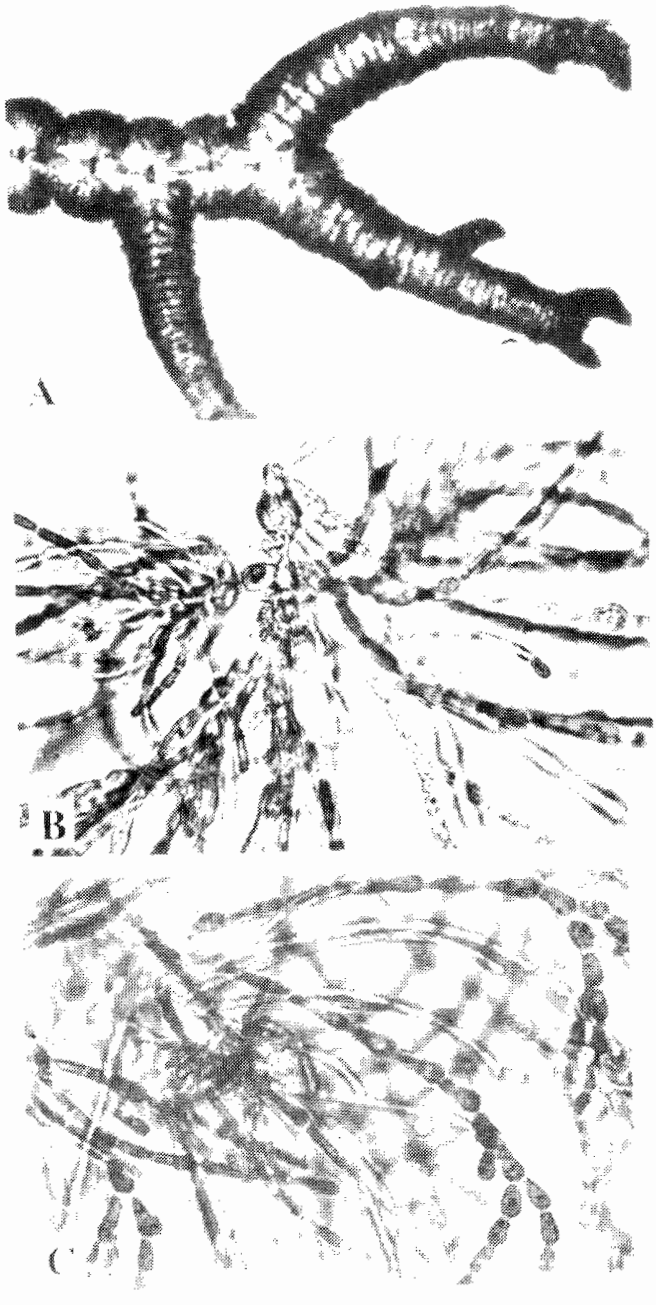

Fig. 2 *Batrachospermum* cf *arcuatum* Kylin.

A Growth habit of the thallus. (x66)

B,C. Nodal region showing carpogonia. (x400)

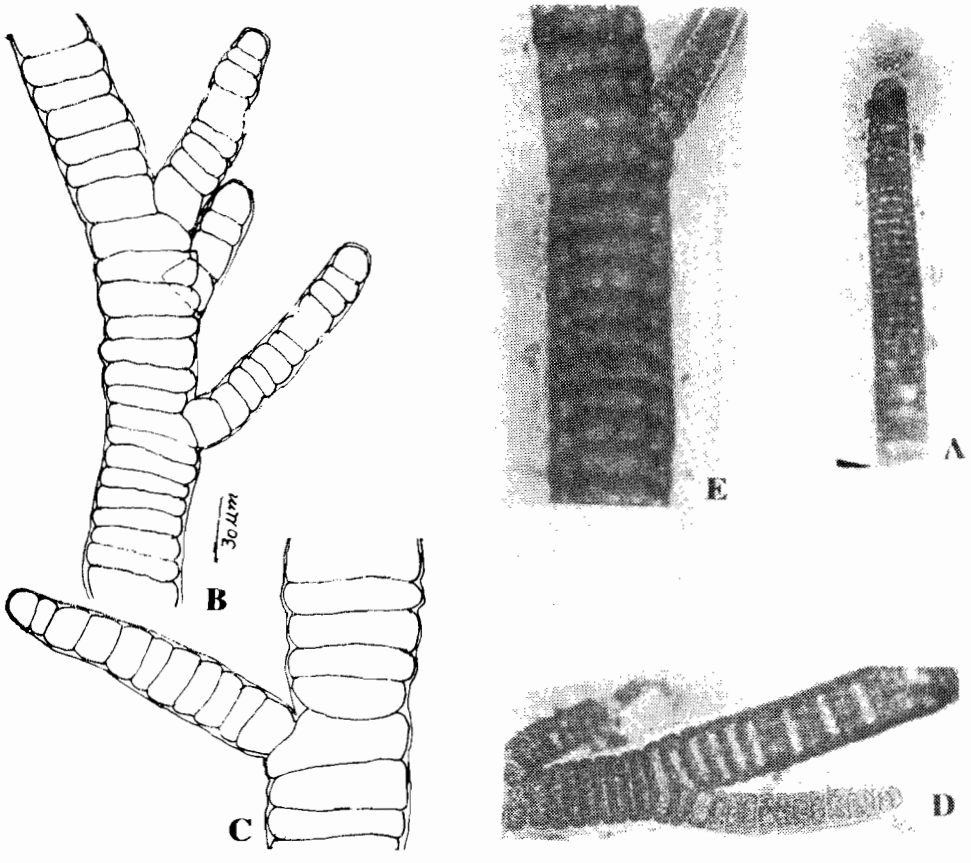

Fig.3. *Compsopogon coeruleus* (Balbis) Montagne.

A,B,C,D. Apex of the thallus showing corticated axil cells and lateral, in corticated branches.

E. Polygonal cortical cells. One to two layers thick surrounding axil cells in the region of the thallus. (x400).

Compsopogon **cf.** *prolificus* **Yadava et Kumano, 1985.**
Vis *et al.*, **1992. 31 (6): 564-575.**
(Fig.4)

Thallus 2-3 cm long with rhizoid on the base main axis 145-500 um broad, cortical cells about 18-30 um broad and 21-30 um long, with the uniseriate branches cortical layer 1-3. *Compsopogon* cf. *prolificus* was found attached with the submerged leafs and sheaths of *Typha domogensis* together with *C. coeruleus*, *A. hermannii*, *lyngbya* sp., and *Oedogonium* sp.

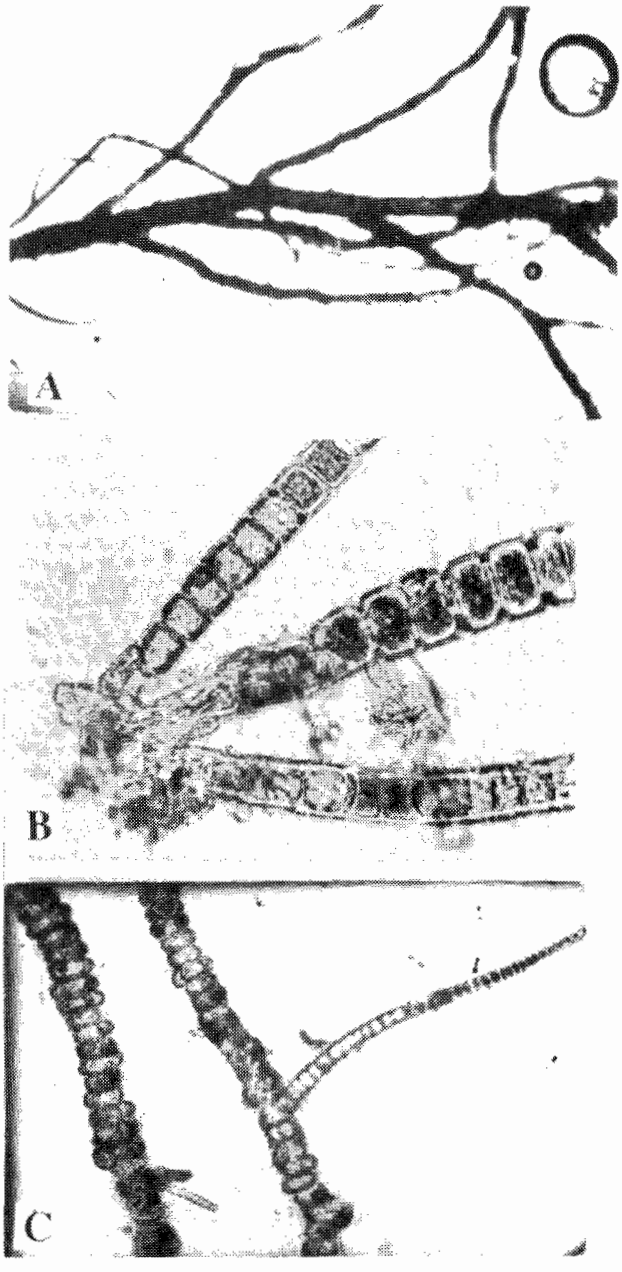

Fig.4. *Compsopogon* of *prolificus* Yadava et Kumano.

A B. Growth habit of the thallus. (x66).

C Thallus showing variation in cell dimensons of uncorticated cells with branch. (x400).

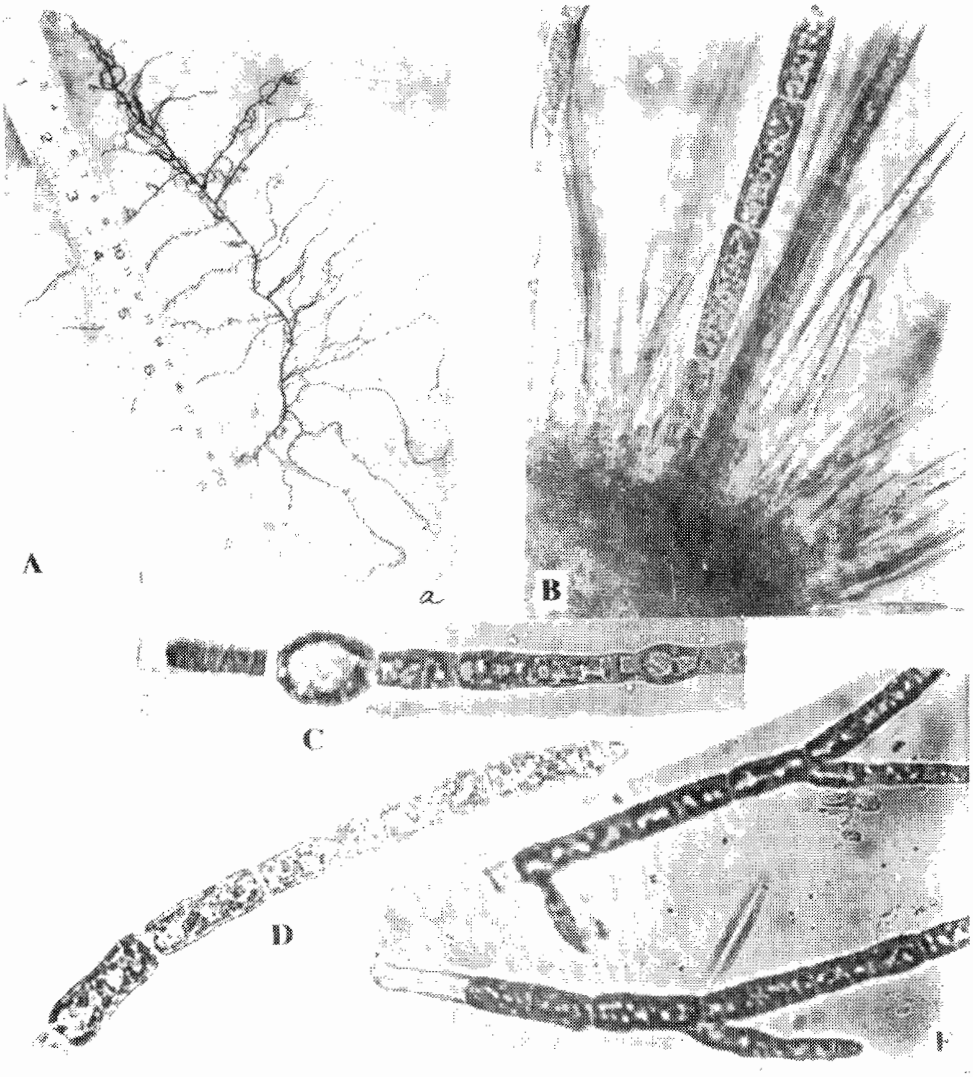

Fig 5 *Thorea hispida* (Thore) Desvaux.

A. Habit of the thallus

B. Portion of the thallus showing branches. (x400)

C. Portion of the filament showing monosporingia. (x400)

D. Portion of the filament showing spores in a series. (x400)

E. Portion of the filament showing dichatomous branches. (x400)

Thorea hispida **(Thore) Desvaux 1818. Sheath *et al*, 1993, 28:231-241; Khan, 1977. 17:55-58. (Fig.5)**

Thallus feathery 23-25 cm, long, benthic thread like profusely branched, covered with branched and unbranched photosynthetic filament with gelatinous matrix. Thallus having irregular photosynthetic filament 300-600 um long, some with shorter filament of 60-80 um in length. Cells of the axil filaments upto 75-90 um long, and 2.5-4 um broad. Axil branches 600-1500 um long and 2.5-4 um broad with branched and unbranched filaments at right angle with 20-30 um cylindrical cells, each cell 35-45 um long and 6.5-8 um broad. Monosporangia 42-48 um long and 12-15 um broad spore is single or in a series of 2-4, 25-30 um long and 9-20 um broad at the periphery of the axil region at the base of photosynthetic filament.

T. hispida was collected during January 1995 from a depth of about 30-45" with a water temperature 20-25^{O}C.

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